PacNET: Pacific Lightning Detection Network to Continuously Monitor Convective Storms Over the Pacific Ocean

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LONG TERM GOALS

To establish a network of five receivers for long range lightning detection in the central north Pacific, with detectors sited in Hawaii, Dutch Harbor, Johnson Island, Kwajalein, and Midway to continuously monitor sferics over the central Pacific Ocean and adjacent land areas.

Data from the Pacific lightning detection NETwork (PacNET) will be streamed via the Internet to a processing center after which the data will be made available in near real time to participants at the Navy (JTWC), the University of Hawaii, the National Weather Service (Aviation Weather Center and NWSFO-HFO), NASA and the Pacific Disaster Center. NASA MSFC will validate the data using LIS on TRMM and conduct synoptic-seasonal-interannual studies of thunderstorms.

Develop synergies with other lightning detection networks such as the European very low frequency (VLF)-detector network.

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SCIENTIFIC OBJECTIVES

The resulting data on lightning stroke frequency and location will be used in conjunction with precipitable water data from ground-based GPS receivers and satellite data to develop guidance tools for real-time storm tracking and warnings over the data-sparse Pacific Ocean.

Processed data from Pacific STARNET will be assimilated into MM5, run operationally in Hawaii by the principal investigator's group. Additionally, the sferics data will be used to support investigations at the University of Hawaii of tropical and subtropical cyclogenesis, cyclone track forecasting, and forecasting flash-flood events over the Pacific.

APPROACH

The wave guide between the Ionosphere and the Earth's surface allows VLF noise generated by lightning between 5 and 15 kHz to propagate over very long distances. In addition low frequency ground wave signals are produced by cloud to ground and in cloud lightning and can be monitored for accurate location determination at closer range. The first step in this project has been to evaluate competing technologies for their suitability in addressing the goals of the project.

WORK COMPLETED, PRELIMINARY RESULTS

Two classes of receivers have been considered. (i) Narrow-band VLF receiver based on the design originally developed by Resolution Displays Inc (RDI), and (ii) Broad-band receiver approach developed by Global Atmospherics, Incorporated (GAI). Progress has been made toward a broad-band approach at utilizes new low noise pre-amps operate down to 15 kHz to achieve improved detection efficiency and location accuracy at long range. Model results for detection efficiency and location accuracy have been obtained for each. Results from the narrow band approach are presented in Fig.1.

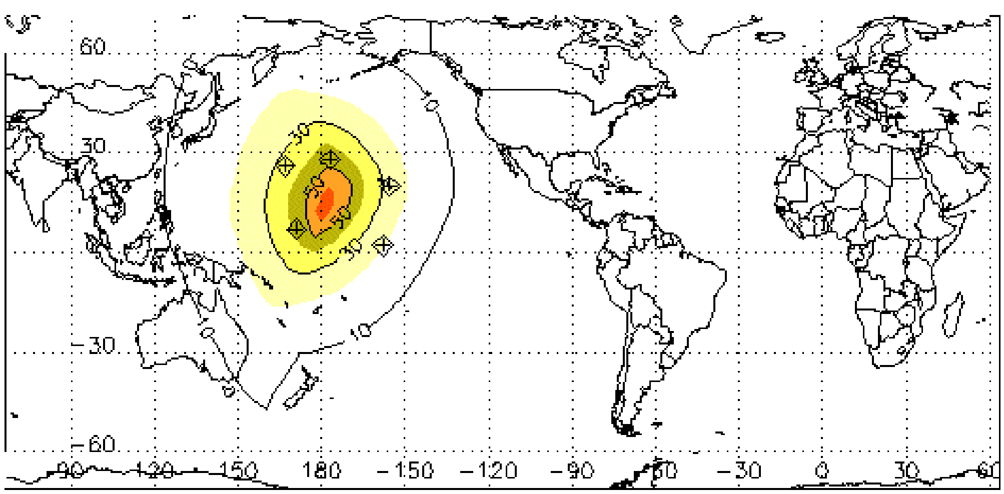

Fig. 1 Modeled cloud to ground detection efficiency (%) at night for Pacific STARNET with 5 narrow band receivers deployed in the central Pacific. Courtesy of Carlos A Morales, Colorado State University (morales@atmos.colostate.edu).

Model results from the broad-band approach are shown in Fig. 2. Elements of the detection efficiency model include (Cummins et al., 1998) (i) source (peak current) distribution, (ii) propagation model (day, night, and ground wave), (iii) sensor sensitivity (POD vs incident signal strength), (iv) location of all sensors. Elements of the location accuracy model include, (i) measured/modeled timing error (RMS = 3 degrees for LR), (ii) measured/modeled angle error (RMS = 5 µSec for LR), (iii) location of all sensors and error ellipse from location algorithm.

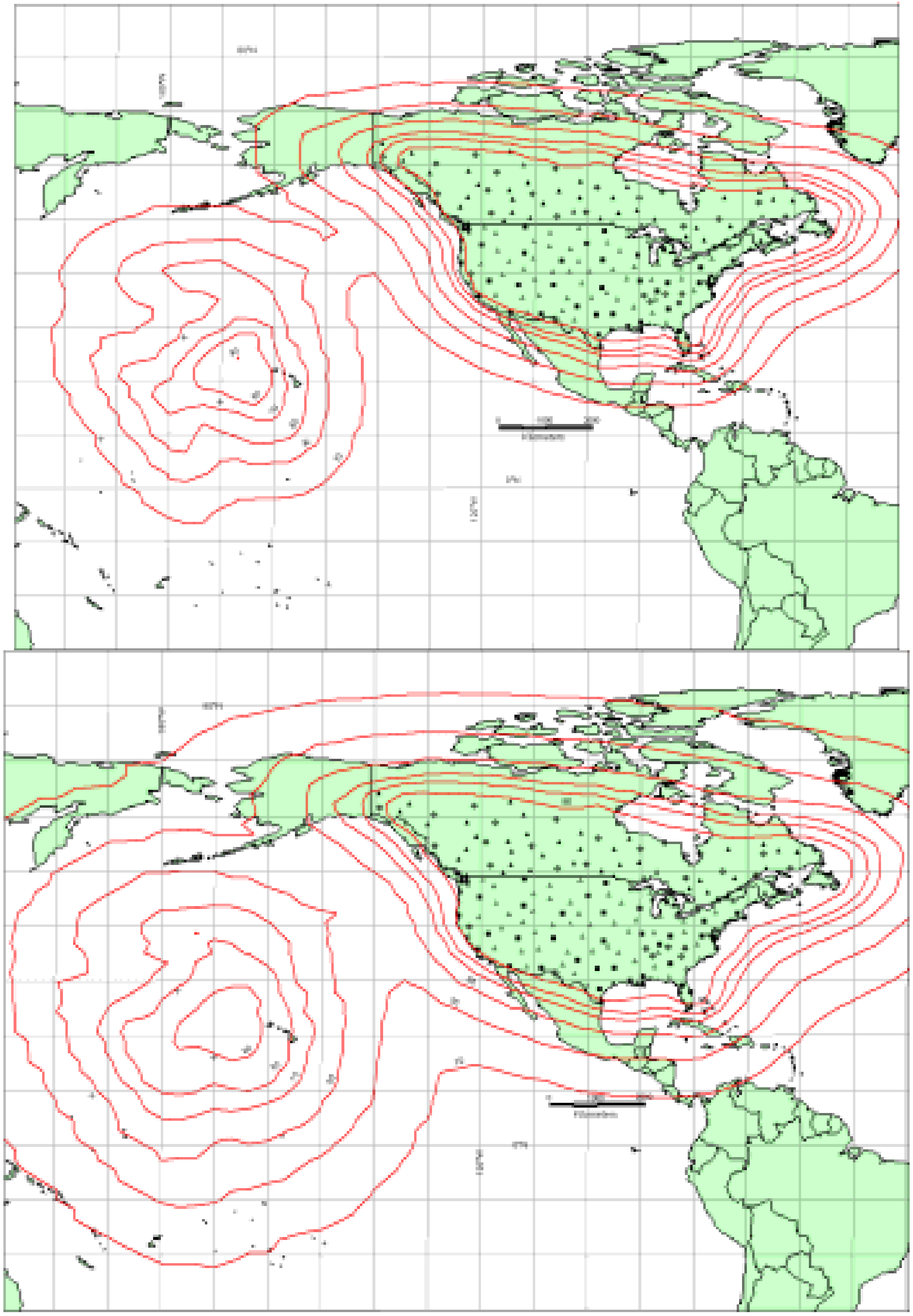

Fig. 2 PacNET modeled performance projections of detection efficiency with data input from the North American Lightning Detection Network. Top panel: daytime, bottom panel: night time. Courtesy of Ken Cummings (kcmobile@glatmos.com), Global Atmospherics, Inc.

IMPACT/APPLICATIONS

Progress has been made toward a broad band approach at utilizes new low noise pre-amps operate down to 15 kHz to achieve improved detection efficiency and location accuracy at long range. The next step is to begin installation of the new detectors and Internet telecommunications equipment in the Pacific.

NASA MSFC will validate the data using LIS on TRMM and conduct synoptic-seasonal-interannual studies of thunderstorms.

The resulting data on lightning stroke frequency and location will be used in conjunction with precipitable water data from ground-based GPS receivers and satellite data to develop guidance tools for real-time storm tracking and warnings over the data-sparse Pacific Ocean.

Processed data from PacNET will be assimilated into MM5, run operationally in Hawaii by the principal investigator's group. Additionally, the sferics data will be used to support investigations at the University of Hawaii of tropical and subtropical cyclogenesis, cyclone track forecasting, and forecasting flash-flood events over the Pacific.

TRANSITIONS

Data from the Pacific lightning detection NETwork (PacNET) will be streamed via the Internet to a processing center after which the data will be made available in near real time to the Navy (JTWC), the University of Hawaii, the National Weather Service (Aviation Weather Center and NWSFO-HFO), NASA and the Pacific Disaster Center. Additionally, guidance tools that will be developed through the project will be made available to operational interests in the Navy, NASA, and NWS.

RELATED PROJECTS

Relationship to NOVA Phase II SBIR: Scientists involved in the PacNET Project are contributing to the NOVA project. Will carry out location processing for the prototype NOVA sensors. GAI plans to commercialize the NOVA sensors if they prove to perform better than IMPACT sensors. If the NOVA sensors perform well in U.S. evaluations, then some number of them (paid for by the SBIR) could be integrated into PacNET. Further details are provided in NOVA's SBIR submission.

European VLF-Detector Network: The European Community has been actively developing a VLF lightning detection network in Europe. Contact has been made with one of the principals (Chris Kidd at the U of Birmingham, C.Kidd@bham.ac.uk) in that effort to facilitate synergy and scientific exchange.

SUMMARY

Goal of project is to develop a long-range lightning detection network for the Pacific. Progress has been made toward a broad band approach at utilizes new low noise pre-amps operate down to 15 kHz to achieve improved detection efficiency and location accuracy at long range. The next step is to begin installation of the new detectors and Internet telecommunications equipment in the Pacific.

REFERENCES

Cummins, K. L., E. A. Brado, W. L. Hiscox, R. B. Pyle, and A. E. Pfifer, 1998: A combined TOA/MDF technology upgrade of the US National Lightning Detection Network. J. Geophys. Res.,103, 9035-9044.